Use of Electrostatic Sprays to Apply Disinfectant to Surfaces Can Help to reduce the Risk of SARS-CoV-2

Submitted by: Mark Hodgson, PathControl, LLC

The present COVID 19 pandemic is transmitted through a virus (SARS-CoV-2) that can persist on environmental surfaces for prolonged periods of time[1]. Viruses on surfaces may be transferred to susceptible individuals via hands. Whilst hand hygiene is critical to reduce transmission, reducing the burden of viral particles on the surface through use of chemical disinfectants is another effective method in minimizing the risk of transmission, on the basis that if a surface is effectively disinfected it cannot be a vector of infection. This may give subsequent occupants of a space a greater feeling of confidence that their risk is reduced.

The EPA has initiated a program for emerging viral pathogens that allows the use of a wide range of disinfectants to help identify those products that are most likely to be effective against SARS-CoV-2 on hard, non-porous surfaces. These disinfectants must be applied to the surface in accordance with the manufacturer's instructions. Most liquid disinfectants have instructions that include application through a mechanical spray device. Such devices are not the same as fogging/misting devices and the EPA has separate and specific guidelines that differentiate fogging or misting based on droplet size. Two EPA guidance notes indicate that droplets smaller than 40 microns or 50 microns are classified as a fog or mist. (EPA Terminology Services - Terminology and Acronyms Report, and April 2013 final signed letter)

Recently a new technology has emerged to improve the application of disinfectants to a surface, this is a mechanical spray that is enhanced via the application of an electrostatic charge to the droplet. Typically the charge applied is electrically positive; this has two impacts, it keeps the droplets separate from each other and attracts them to surfaces which are generally negatively charged.

There are many different devices on the market but they generally each follow a common protocol, disinfectant in liquid form is pumped through a nozzle to produce a spray. The size of droplet generated varies depending on the manufacturer of the device, with particle sizes ranging from 5 microns up to 120 microns in diameter. On this basis, some of these devices would fall within the EPA defined range of foggers or misters, and are not covered in this evaluation. For those devices that generate droplets > 50 microns we recommend that such devices be considered as mechanical sprays.

The application of an electrostatic charge is by a high voltage field in the nozzle of the electrostatic device. The electric charge is high voltage but with low current flow. Typically, the instrument is grounded, either through the mains electrical supply or through the operator for battery devices. The non-arcing electric field in the nozzle that removes electrons from the outside of the disinfectant droplet produces a net positive charge on the exterior of the droplet but does not alter the chemical composition of the disinfectant. Attached is a copy of one study that looks at the free chlorine residual in a disinfecting solution before and after passing through the electrostatic device with shows no significant reduction in the level of active in the device. (Attachment 1)

Previously the EPA have expressed concerns that the smaller droplet sizes may result in insufficient wetting of a surface or rapid drying, resulting in an ineffective disinfection. A published EPA study shows that even when droplets as small as 40 microns are generated this is not the case, and disinfection is still attained[2]. This study was particularly challenging as fabrics were also considered which are porous rather than, hard non- porous surfaces. We have in addition presented a laboratory study evaluating the drying time or electrostatic droplets on surfaces. This study clearly shows that attaining wet contact times of 10 min are easily attained with a single application of the spray. Wet times of 10 min would accommodate any EPA registered disinfectant found on the N list. (Attachment 2)

On the basis of the information above, we are requesting that Electrostatic Sprays be treated the same way as Mechanical Sprays for EPA application purposes, that the differentiation between spray devices be made based only based on droplet size (<-50 microns classified as fogging) and that all larger droplet sizes (i.e. ≥ 50 microns) be classified as a mechanical spray. This will significantly improve the overall application of disinfectants in terms of speed of application, reduced over spray, more even distribution of spray on to a surface, and improving overall application of disinfectants. Manufacturers should be asked to show that there is minimal chemical exposure to the device operator (through air sampling in accordance with NIOSH protocols) and that flammable or volatile compounds should not be put through the devices. All suitable products (i.e. those which are applied in liquid form) which are included on the list N should be considered as suitable for this application and devices generating droplets of over 50 microns should be considered.

References

1. Günter Kampf, Daniel Todt, Stephanie Pfaender, Eike Steinmann Jan 2020, Persistence of coronaviruses on inanimate surfaces and its inactivation with biocidal agents, *Journal of Hospital Infection*
DOI: https://doi.org/10.1016/j.jhin.2020.01.022

2. Evaluation of Electrostatic Sprayers for Use in a Personnel Decontamination Line Protocol for Biological Contamination Incident Response Operations EPA/600/R-18/283 | September 2018

Report on the examination of Klorsept (EPA Reg No: 71847-6) in combination with the Protexus PX200ES cordless electrostatic sprayer, when prepared using deionized water and 350 – 400ppm Hard Water

Medentech

Clonard

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NO CLAIM OF CONFIDENTIALITY

No claim of confidentiality, on any basis whatsoever, is made for any information contained in this document. I acknowledge that information not designated as within the scope of FIFRA sec. 10(d)(1)(A), (B), or (C) and which pertains to a registered or previously registered pesticide is not entitled to confidential treatment and may be released to the public, subject to the provisions regarding disclosure to multinational entities under FIFRA 10(g).

Submitter: _________________________ Date: _________

Typed Name of Signer: _____________________________

Typed Name of Company: ________Medentech_________

GOOD LABORATORY PRACTICE STATEMENT

This study was carried out in-house by Medentech and was not conducted under GLP conditions. Medentech is a GMP certified facility, and method of determination of NaDCC Content in solution was performed using a validated test method. Hard water was prepared from certified hard water preparation, and ppm confirmed using test strips.

Sponsor/Submitter: ______________________________ Date: ____________________

Name: Sinead Whelan Buckley
Title: Regulatory Specialist

Study Director: ______________________________ Date: ____________________

Name: Dr. Sarah Finn
Title: R&D Scientist

CONTENTS

Report Title: **Report on the examination of Klorsept (EPA Reg No: 71847-6) in combination with the Protexus PX200ES cordless electrostatic sprayer, when prepared using deionized water and 350 – 400 ppm Hard water.**

Date Commenced: 29th January 2018

Date Completed: 05th February 2018

Report No.: RD148-001R

1.0 INTRODUCTION

This study was conducted to assess whether the Protexus PX200ES cordless electrostatic sprayer has any effect on the available chlorine concentration of a solution of Klorsept. Solutions of known concentration were prepared in either deionized water or hard water (350-400 ppm). These were then passed through two nozzle types on the Protexus PX200ES. Samples were analysed for their Sodium dichloro-s-triazinetrione (NaDCC) content using a validated iodometric assay.

2.0 AIM

To determine whether available chlorine concentration of a Klorsept solution is affected when used in conjunction with the Protexus PX200ES cordless electrostatic sprayer. In accordance with Medentech validation standards there should be no more than ±3.0% variance in the available chlorine concentration compared to the control (100%) in order to demonstrate there is no affect on the chlorine concentrations after passing through the PX200ES.

3.0 METHOD

3.1 Preparation of Hard Water

Reagents/Chemicals used for preparation:

Deionized (DI) water
Magnesium Chloride (anhydrous)
Calcium Chloride
Sodium Bicarbonate

Two solutions were prepared to make the 350-400 ppm hard water solution.

Hard water solution one:

7.94 g of Magnesium Chlorine (anhydrous) and 18.50 g of calcium chloride were dissolved in DI water and brought to a volume of 250 ml.

Hard water solution two:

14.01 g of Sodium Bicarbonate was dissolved in DI water and brought to a volume of 250 ml.

In a volumetric flask, approximately ¾ of the total deionized water which was going to be converted to hard water was added. The appropriate volume of hard water solution one and hard water solution two were added according to US EPA SOP Number MN-30-00. The volumetric flask was then filled to the mark with deionised water. Hard water test strips were then used to confirm the hardness of the water. It was confirmed that the hardness of the water was in the 350 – 400 ppm range prior to preparation of test solutions.

3.2 Preparation of Klorsept Solutions

Test solutions were prepared in accodance with Table 1 using DI water or 350-400 ppm hard water (section 3.1). Each test solution was prepared in duplicate. Standard 3.3 g finished weight tablets of Klorsept (EPA Reg No.: 71847-6) were used. As per EPA label 71847-6, each tablet contains 48.21% NaDCC which is equivalent to 31.10% active chlorine by tablet weight. It was ensured that tablets were fully dissolved prior to testing and were stirred briefly prior to carrying out NaDCC assay (section 3.4).

Table 1: Test solutions used in this study

Test solution designation	Batch No.	No. of tablets	Volume of water	Water type
A	J337	1	1000 ml	DI
B	J337	1	1000 ml	Hard water
C	J337	4	1000 ml	DI
D	J337	4	1000 ml	Hard water
E	J112	1	1000 ml	DI
F	J112	1	1000 ml	Hard water
J	J112	4	1000 ml	DI
H	J112	4	1000 ml	Hard water

3.3 Use of the Protexus PX200ES cordless electrostatic sprayer

The Protexus PX200ES was operated in accordance with the manufacturers instructions. For the purpose of this testing, nozzle 8C and nozzle 9C were used. Test samples (500 ml) were loaded into the tank of the machine. Samples were sprayed and collected in a clean glass beaker. These were then analysed for their NaDCC concentration as per section 3.4.

3.4 Analysis of NaDCC concentration

NaDCC concentration was determined by titration based on the liberation of iodine from potassium iodide by available chlorine.

For test solutions A, B, E and F (Table 1), 25 ml of the test solution was transferred to a clean 250 ml conical flask by pipette. DI water (25 ml) was then added to the conical flask using a Grade A graduated cylinder. Duplicate samples were prepared

For test solutions C, D, J and H (Table 1), 5 ml of the test solution was transferred to a clean 250 ml conical flask by pipette. DI water (45 ml) was then added to the conical flask using a Grade A graduated cylinder. Duplicate samples were prepared

To each sample, 5 ml glacial acetic acid and 10 ml 20% potassium iodide were added to the conical flask and the solution mixed by agitation. The liberated iodine was titrated in each flask to a colourless end point with 0.1N sodium thiosulphate VS using a few drops of start indicator to aid end point determination. The average NaDCC content per tablet was calculated using the equation below.

Calculation 1: Anhydrous NaDCC [$NaCl_2(NCO)_3$] content per tablet

$$= \frac{\text{titre x F x 5.4975 x theoretical tablet/sample NaDCC content}}{\text{Sample NaDCC content}}$$

Titre = ml of sodium thiosulphate used in assay

F = “Factor” from certificate of analysis for 0.1N Sodium Thiosulphate

Theoretical tablet/sample NaDCC content = 1670 mg

Sample NaDCC content (sample A, B, E and F) = 41.75 mg

Sample NaDCC content (sample C, D, J and H) = 33.4 mg

To convert this result into ppm of available chlorine per solution, the following calculation was used:

Calculation 2: Approximate ppm of available chlorine per solution

(Calculation 1 result x 0.645) x Number of tablets used to prepare solution

Reagents used in the analysis of NaDCC concentration in this study were as follows:

Sodium Thiosulphate, Lot No: LM1965 and LM1963

Glacial Acetic Acid, Lot No: LM1986 and LM1987

20% Potassium Iodide solution: LS4761 and LS4764

Starch Solution: LS4752 and LS4763

4.0 RESULTS/DISCUSSION

Results are outlined in Table 2. These results are the average of independant replicates. In each test, the approximate available chlorine in the solutions after passing through the PX200ES system was compared to the approximate available chlorine in the original solution pre-spray, which was taken to be 100%. For test solution A and H, nozzle 8C and 9C were examined on separate days, meaning different pre-spray solutions were used. This is noted in Table 2 by separating results into A-1, A-2 and H-1, H-2.

All samples showed no more that ±3.0% variance in the available chlorine concentration compared to the control (100%) after being sprayed using either the 8C or 9C nozzle of the PX200ES. In accordance with Medentech validation standards, this indicated that there was no significant different in NaDCC/available chlorine content after solutions had been sprayed witht the Protexus PX200ES apparatus, nozzle 8C or 9C.

Table 2: Examination of the NaDCC content in end use dilutions before and after passing through the Protexus PX200ES sprayer using two different nozzle sizes

				Solution pre-spray		Protexus PX200ES: Nozzle 8C			Protexus PX200ES: Nozzle 9C		
Test solution designation	Batch No.	No. of tablets added to 1000 ml	Water type*	Anhydrous NaDCC content per tablet (mg)	Approximate ppm of available chlorine (per 1000 ml)	Anhydrous NaDCC content per tablet	Approximate ppm of available chlorine (per 1000 ml)	% available chlorine after spray vs. solution pre-spray	Anhydrous NaDCC content per tablet	Approximate ppm of available chlorine (per 1000 ml)	% available chlorine after spray vs. solution pre-spray
A-1	J337	1	DI	1751.96	1130.01				1779.41	1147.72	101.57
A-2	J337	1	DI	1761.10	1135.91	1750.12	1128.83	99.38			
B	J337	1	Hard water	1729.98	1115.84	1740.97	1122.92	100.63	1735.47	1119.38	100.32
C	J337	4	DI	1736.85	4481.06	1695.66	4374.79	97.63	1702.52	4392.50	98.02
D	J337	4	Hard water	1699.02	4383.47	1729.98	4463.35	101.82	1723.12	4445.64	101.42
E	J112	1	DI	1653.10	1066.25	1670.08	1077.20	101.03	1669.57	1076.87	101.00
F	J112	1	Hard water	1669.57	1076.87	1686.05	1087.50	100.99	1675.05	1080.41	100.33
J	J112	4	DI	1675.06	4321.65	1668.20	4303.94	99.59	1668.20	4303.94	99.59
H-1	J112	4	Hard water	1647.60	4250.81	1668.20	4303.94	101.25			
H-2	J112	4	Hard water	1798.63	4640.47				1771.17	4569.62	98.47

*DI water or 350-400 ppm hard water used

5.0 CONCLUSION

When using nozzle 8C or 9C of the Protexus PX200ES electrostatic sprayer, it did not influence the available chlorine concentration of the Klorsept (EPA Reg No: 71847-6) solutions tested when prepared using deionized water or 350 – 400 ppm hard water.

6.0 APPROVAL OF REPORT

Compiled by: ___________________________ Date: ______________________

Name: Dr. Sarah Finn

Role: Research & Development Scientist

Approved by: ___________________________ Date: ______________________

Name: Sinead Whelan Buckley

Role: Regulatory Affairs Specialist

Approved by: ___________________________ Date: ______________________

Name: Julie Lambert

Role: Quality Assurance & Technical Manager

Attachment 2

Report on the examination of drying time of a Klorsept (EPA Reg No: 71847-6) solution prepared using 350 - 400 ppm hard water when sprayed on a ceramic tile using the Protexus PX200ES cordless electrostatic sprayer

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Submitter: ________________________ Date: _________

Typed Name of Signer: ____________________________

Typed Name of Company: ________Medentech_________

GOOD LABORATORY PRACTICE STATEMENT

This study was carried out in-house by Medentech and was not conducted under GLP conditions. Medentech is a GMP certified facility, and method of determination of NaDCC Content in solution was performed using a validated test method. Hard water was prepared from certified hard water preparation, and ppm confirmed using test strips.

Sponsor/Submitter: ______________________________ Date: ____________________

Name: Sinead Whelan Buckley
Title: Regulatory Manager

Study Director: ______________________________ Date: ____________________

Name: Dr. Sarah Finn
Title: R&D Scientist

CONTENTS

Report Title:	**Report on the examination of drying time of a Klorsept (EPA Reg No: 71847-6) solution prepared using 350 - 400 ppm hard water when sprayed on a ceramic tile using the Protexus PX200ES cordless electrostatic sprayer**
Date Commenced:	27th September 2018
Date Completed:	1st October 2018
Report No.:	RD148-006R

7.0 INTRODUCTION

This study was conducted to estimate the drying time of a Klorsept solution prepared using hard water (350-400 ppm) when sprayed using the Protexus PX200ES cordless electrostatic sprayer onto a ceramic tile of dimensions 24.8 cm x 60 cm.

Previous work has demonstrated that there is no effect on available chlorine concentration when a Klorsept solution is passed through the Protexus PX200ES (RD148_001R.Rev0). According to EPA Reg No: 71847-6 Master Label, the contact time of efficacy claims range from 1 min to 30 min. The drying time of a Klorsept solution will be examined when sprayed onto a surface using the Protexus PX200ES to determine which efficacy claims could be achieved in conjunction with the Protexus PX200ES.

8.0 AIM

To determine the drying time of known Klorsept solutions prepared using hard water (350-400 ppm) over a defined area when sprayed using the Protexus PX200ES electrostatic sprayer.

9.0 METHOD

3.1 Preparation of Hard Water

Reagents/Chemicals used for preparation:

Deionized (DI) water

Magnesium Chloride (anhydrous)

Calcium Chloride

Sodium Bicarbonate

Hard Water test strips (Waterworks ™ Total Hardness Water Quality Test Strips; 0-1000 ppm)

Two solutions were prepared to make the 350-400 ppm hard water solution.

Hard water solution one:

7.94 g of Magnesium Chloride (anhydrous) and 18.50 g of calcium chloride were dissolved in DI water and brought to a volume of 250 ml.

Hard water solution two:

14.01 g of Sodium Bicarbonate was dissolved in DI water and brought to a volume of 250 ml.

In a volumetric flask, approximately ¾ of the total deionized water which was going to be converted to hard water was added. The appropriate volume of hard water solution one and hard water solution two were added according to US EPA SOP Number MN-30-00. The volumetric flask was then filled to the mark with deionised water. Hard water test strips were then used to confirm the hardness of the water. It was confirmed that the hardness of the water was in the 350 – 400 ppm range prior to preparation of test solutions.

3.2 Preparation of Klorsept Solutions

Test solutions were prepared in accordance with Table 1 using 350-400 ppm hard water (Section 3.1). Standard 3.3 g finished weight tablets of Klorsept (EPA Reg No.: 71847-6) were used. As per EPA label 71847-6, each tablet contains 48.21% NaDCC which is equivalent to 31.10% active chlorine by tablet weight. It was ensured that tablets were fully dissolved prior to testing and were stirred briefly prior to carrying out NaDCC assay (Section 3.3) to ensure that solutions were of the correct concentrations.

Table 1: Test solutions used in this study

Test solution designation	Batch No.	No. of tablets	Volume of water	Water type
A	K115	1	1000 ml	Hard water

B	K115	4	1000 ml	Hard water
C	K833	1	1000 ml	Hard water
D	K833	4	1000 ml	Hard water

3.3 Analysis of NaDCC concentration

NaDCC concentration was determined by titration based on the liberation of iodine from potassium iodide by available chlorine.

For test solutions A and C (Table 1), 25 ml of the test solution was transferred to a clean 250 ml conical flask by pipette. DI water (25 ml) was then added to the conical flask using a Grade A graduated cylinder. Duplicate samples were prepared.

For test solutions B and D (Table 1), 5 ml of the test solution was transferred to a clean 250 ml conical flask by pipette. DI water (45 ml) was then added to the conical flask using a Grade A graduated cylinder. Duplicate samples were prepared.

To each sample, 5 ml glacial acetic acid and 10 ml 20% potassium iodide were added to the conical flask and the solution mixed by agitation. The liberated iodine was titrated in each flask to a colourless end point with 0.1 N sodium thiosulphate VS using a few drops of start indicator to aid end point determination. The average NaDCC content per tablet was calculated using the equation below.

Calculation 1: Anhydrous NaDCC [$NaCl_2(NCO)_3$] content per tablet

$$= \frac{\text{titre x F x 5.4975 x theoretical tablet/sample NaDCC content}}{\text{Sample NaDCC content}}$$

Titre = ml of sodium thiosulphate used in assay

F = “Factor” from certificate of analysis for 0.1 N Sodium Thiosulphate

Theoretical tablet/sample NaDCC content = 1670 mg

Sample NaDCC content (sample A, and C) = 41.75 mg

Sample NaDCC content (sample B, and D) = 33.4 mg

To convert this result into ppm of available chlorine per solution, the following calculation was used:

Calculation 2: Approximate ppm of available chlorine per solution

(Calculation 1 result x 0.645) x Number of tablets used to prepare solution

Reagents used in the analysis of NaDCC concentration in this study were as follows:

Sodium Thiosulphate, Lot No: LM2019

Glacial Acetic Acid, Lot No: LM2130

20% Potassium Iodide solution: LS4868

Starch Solution: LS4867

3.4 Examination of drying time using the Protexus PX200ES electrostatic sprayer

The Protexus PX200ES was operated in accordance with the manufacturer's instructions. Test solutions (500 ml) were loaded into the tank of the machine. A ceramic tile of dimensions 24.8 x 60 cm was sprayed from top to bottom with one motion that ensured complete coverage of the tiles in a fine spray. The timer was initiated immediately after spraying the tile. The time at which the tile was completely dry, i.e. no visible moisture remaining, was determined. The experiment was carried out at 20°C ± 5°C. Three replicates were carried out for each solution prepared.

10.0 RESULTS/DISCUSSION

The solution concentrations are outlined in Table 2. All results were within the desired range.

The average drying times are outlined in Table 3. These results are the average of three independent replicates for each prepared solution (Table 1) and each nozzle of the Protexus PX200ES. All test solution/nozzle combinations had an average drying time ≥18.53 min (Figure 1) with one application. Drying times were similar when different Klorsept concentrations were used (1076 ppm or 4306 ppm available chlorine). According to these data in combination with data from RD148_001R.Rev0, efficacy claims with a concentration of 1076 ppm or 4306 ppm available chlorine and a contact time ≤10 min according to the Klorsept Master Label (EPA Reg No.: 71847-6) would be achieved with one application spray to a hard, non-porous surface using the PX200ES. However, efficacy claims with a contact time of 30 min as per Klorsept Master Label (EPA Reg No.: 71847-6) would require two staggered applications using the PX200ES in order to reach 30 min contact time.

Table 2: Examination of the concentrations of chlorine in the solutions used in the Protexus PX200ES electrostatic sprayer.

	Batch No.	No. of Tablets	Solution	Anhydrous NaDCC content per tablet (mg/tablet)	Approximate ppm of available chlorine (mg/L)
PX200ES	K115	1	A	1694.92	1093.22
		4	B	1650.89	4259.30
	K833	1	C	1694.92	1093.22
		4	D	1664.66	4294.82

Table 3: Average drying times of Klorsept solutions sprayed onto a 24.8 cm x 60 cm ceramic tile with the Protexus PX200ES electrostatic sprayer using two different nozzle sizes

		Drying time (minutes)	
Solution	**Nozzle**	**Average**	**Standard deviation**
A	**8C**	26.97	7.75
	9C	21.12	0.46
B	**8C**	22.72	1.78
	9C	24.04	4.19
C	**8C**	23.64	3.53
	9C	24.64	2.39
D	**8C**	24.72	1.25
	9C	18.53	5.00

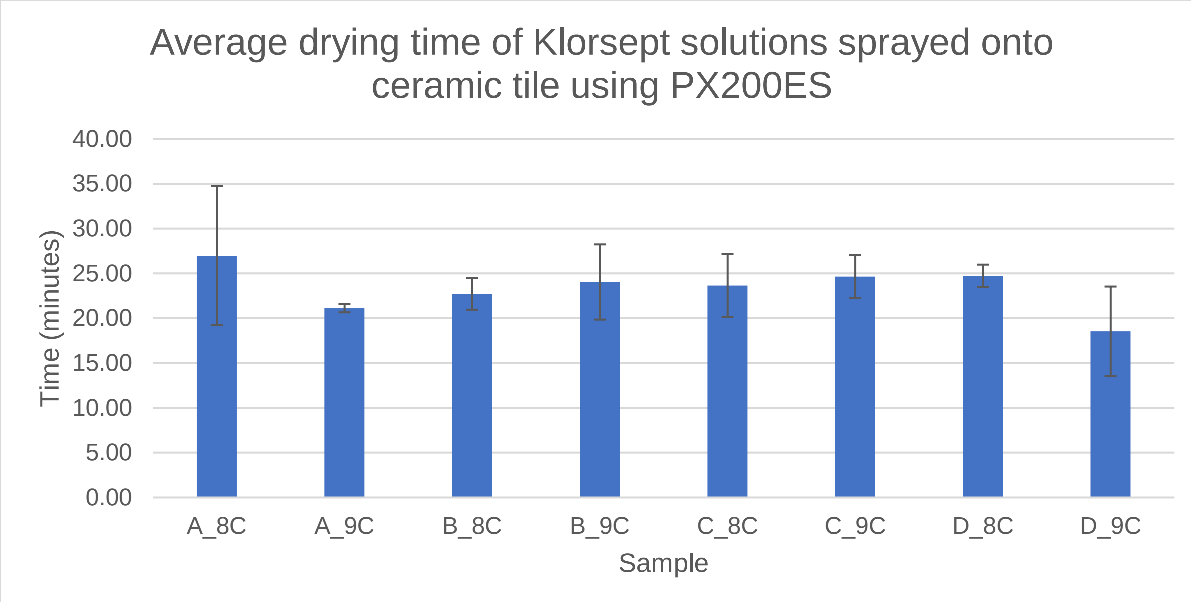

Figure 1: Average drying of Klorsept solutions sprayed onto a ceramic tile using the PX200ES

11.0 CONCLUSION

These data demonstrate that efficacy claims with a contact time ≤10 min according to the Klorsept Master Label (EPA Reg No.: 71847-6) would be achieved with one application spray to a hard, non-porous surface using the PX200ES. However, efficacy claims with a contact time of 30 min as per Klorsept Master Label (EPA Reg No.: 71847-6) would require two staggered applications using the PX200ES in order to reach 30 min contact time.

12.0 APPROVAL OF REPORT

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